Proposal

on

Energy-Efficient Wireless Sensor Networks

Under the Guidance of:
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Course Work Subjects

- Research Methodology (ET 901)
- Wireless Sensor Networks (EC 570)
- Seminar (EC 701)
- Foreign Language (FL 811)

My Date of Registration is 13 August 2012. Above mentioned are the list of subjects which was finalized in my SRC. In 2012-2013 I have passed all the subjects.

Introduction

A wireless sensor network consists of small sensor nodes with sensing, computation, and wireless communications capabilities [1]. Energy consumption is an important issue in the design of wireless sensor networks which typically rely on nonrenewable energy sources like batteries for power.

The components of a (remote) sensing node include the following:

1. A sensing and actuation unit (single element or array)
2. A processing unit
3. A communication unit
4. A power unit
5. Other application-dependent units

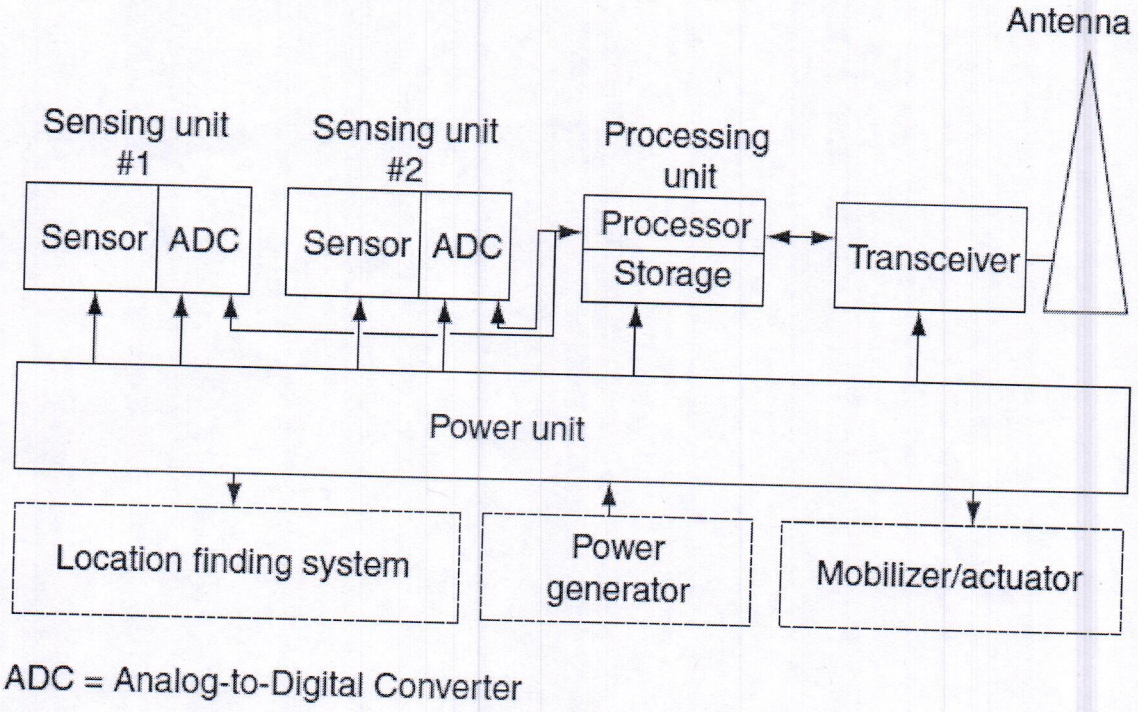


Fig 1: Typical Sensing Node

Some of the characteristic features of sensor networks include the following:

1. Sensor nodes are densely deployed.
2. Sensor nodes are prone to failures.
3. The topology of a sensor network changes very frequently.
4. Sensor nodes are limited in power, computational capacities, and memory.
5. Sensor nodes may not have global identification because of the large amount of overhead and the large number of sensors.

Applications of Sensor Networks

Recent advances in miniaturization and low-cost, low-power design have led to active research in large-scale networks of small, wireless, low-power sensors and actuators. A **short list** of applications is as follows:

1. Military applications
   i. Monitoring inimical forces
   ii. Monitoring friendly forces and equipment
   iii. Military-theater or battlefield surveillance
   iv. Targeting
   v. Battle damage assessment
   vi. Nuclear, biological, and chemical attack detection and more . . .

2. Environmental applications
   i. Microclimates
   ii. Forest fire detection
   iii. Flood detection
   iv. Precision agriculture and more . . .

3. Health applications
   i. Remote monitoring of physiological data
   ii. Tracking and monitoring doctors and patients inside
   iii. Drug administration
   iv. Elderly assistance and more . . .

4. Home applications
   i. Home automation
   ii. Instrumented environment
   iii. Automated meter reading and more . . .

5. Commercial applications
   i. Environmental control in industrial and office buildings
   ii. Inventory control
   iii. Vehicle tracking and detection
   iv. Traffic flow surveillance and more . . .

Importance of Energy Efficient Design:

1. To increase Network Lifetime so that our network will work in drastic conditions.
2. It can accommodate new devices at any time.

Power management [2] is an important issue in wireless sensor networks (WSNs) because wireless sensor nodes are usually battery powered, and an efficient use of the available battery power becomes an important concern specially for those applications where the system is expected to operate for long durations. This necessity for energy efficient operation of a WSN has prompted the development of new protocols in all layers of the communication stack. If the radio transceiver is the most power consuming component of a typical sensor node, large gains can be achieved at the link layer where the medium access control(MAC) protocol controls the usage of the radio transceiver unit.

Problems Faced when there is skew in Time Synchronization:

Traditionally, time synchronization is maintained by pre synchronizing the clocks. Then nodes clock are time stamped. For low energy radio operation of TDMA scheduling is done. A technique used to conserve energy is to turn off the radio periodically and wake up to exchange messages, then go back to sleep again [3][4].Various TDMA schemes proposed for ad hoc networks consider clock synchronization [5]. A costly technique in this field is Global positioning system to synchronize nodes. The technique known as Post facto synchronization proposed by Elson and Estrin [6] is based on synchronized local clocks but transmit range is limited to mobile computing nodes. It lacks a deterministic bound on the clock drift but the precision achieved by them is very good. Time synchronization is a critical piece of infrastructure in any distributed system, but wireless sensor networks make particularly extensive use of synchronized time. Almost any form of sensor data fusion or coordinated actuation requires synchronized physical time for reasoning about events in the physical world. However, while the clock accuracy and precision requirements are often stricter in sensor networks than in traditional distributed systems, energy and channel constraints limit the resources available to meet these goals. The nodes operating in WSN works independently and their clocks may or may not be synchronized with one another. Such situation can cause difficulty while interpreting the information sensed at nodes. Hence time synchronization is important for Routing, Power conservation, Lifetime, Scheduling. The nodes operating in WSN works independently and their clocks may or may not be synchronized with one another. Such situation can cause difficulty while interpreting the information sensed at nodes. Hence time synchronization is important for Routing, Power conservation, Lifetime, Scheduling.

One of the main design goals of WSNs is to carry out data communication while trying to prolong the lifetime of the network and prevent connectivity degradation by employing Time synchronization technique.

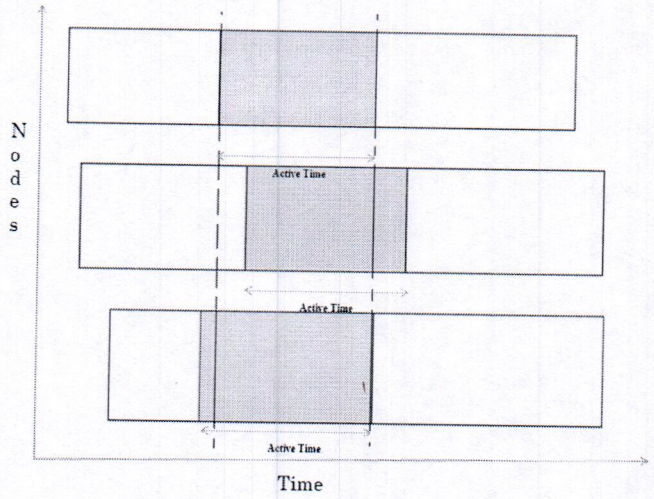


Fig 2:Time Asynchronization

To analyze the time synchronization between nodes I have simulated a WSN comprising of 500 nodes in terrain size of 100m ×100m on Qualnet 6.1 software.

Fig 3: Simulation scenario

With the use of QualNet 6.1 we have studied different parameters for two cases.

Parameters	Time synchronized	2% Skewed Timing
Network lifetime (Days)	32.39617673	23.97446815
Unicast Received Throughput (bits/second)	1461.139	1200.035
Number Of Data Packets Dropped Due To Channel Access Failure	24113	52603
Average Unicast End-to-End Delay (seconds)	0.395066	0.966059
Average Unicast Jitter(seconds)	0.540841	1.288535

Table 1 Comparison of various parameters

Network life time is defined in terms number of surviving nodes after a particular interval of time. This may be calculated with the help of Residual battery capacity. Fig 4 shows the Network Lifetime.

Throughput is one of the dimensional parameters of the network which gives the fraction of the channel capacity used for useful transmission when network selects a destination at the beginning of the simulation i.e. information whether or not data packets were correctly delivered to the destinations. Fig 5 shows Unicast received Throughput.

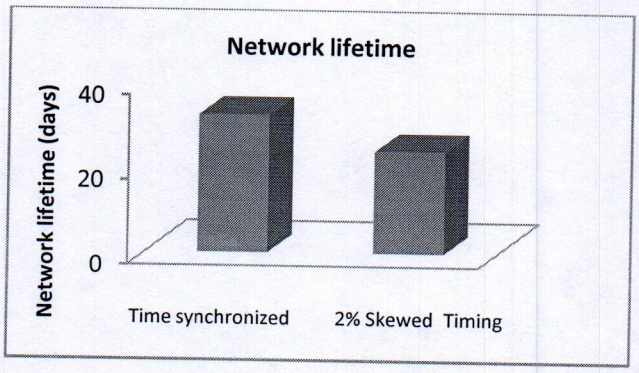


Fig 4: Network lifetime

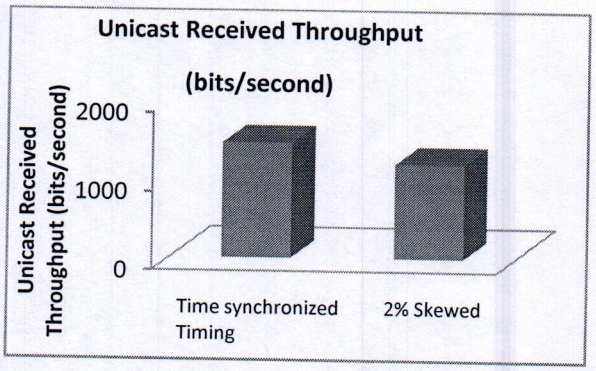


Fig 5:Unicast Received Throughput

The Average End-to-End Delay of data packets is the interval between the data packets generation time and time when the last bit arrives at the destination. Fig 6 shows Average End to End delay.

Average Jitter is the variation of the packet-arrival times between the two successive packets received. Fig 7 shows Average Unicast Jitter [7].

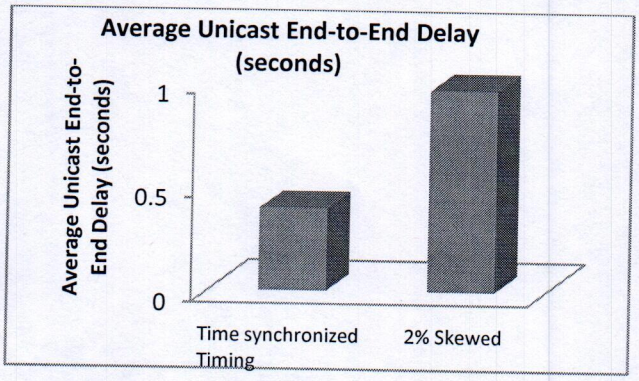


Fig 6:Average Unicast End to End delay

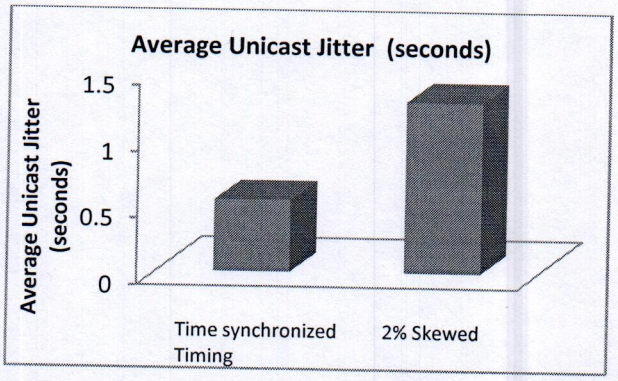


Fig 7:Average Unicast Jitter

Number of data Packets dropped due to channel access failure:-It tells the number of packets dropped when the channel is proceeding to failure point. Fig 8 shows Number Of Data Packets Dropped Due To Channel Access Failure.

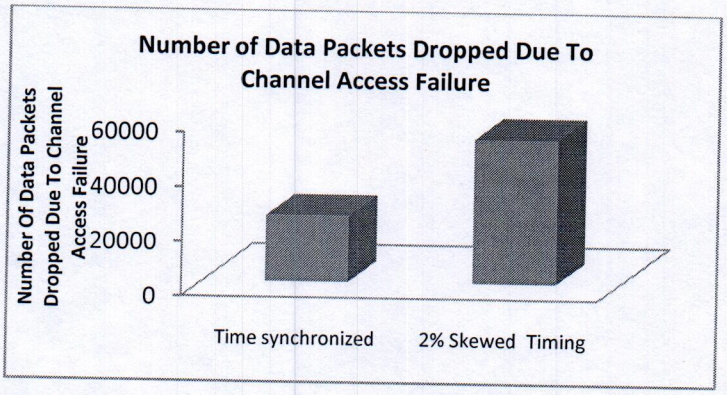


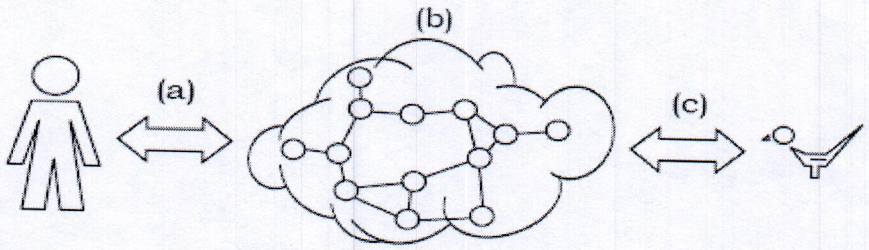
Fig 8: Number of Data Packets Dropped Due To Channel Access Failure

Future Work

Physical time plays a crucial role for many sensor-network applications. While many traditional applications of time also apply to sensor networks, we will focus here on areas specific to sensor networks. Fig 9 illustrates a rough classification of applications of physical time: (a) at the interface between the sensor network and an external observer, (b) among the nodes of the sensor network, and (c) at the interface between the sensor network and the observed physical world. The following paragraphs will discuss applications of time in these three domains. Note that some applications are hard to assign to a single domain. In such cases, we picked the most appropriate domain.

a) ***Sensor network – observer*** In many applications, a sensor network interfaces to an external observer for tasking, reporting results, and management. This observer may be a human operator or an autonomous computing system. Tasking a sensor network often involves the specification of time windows of interest such as "only during the night". For example, the times of occurrence of physical events are often crucial for the observer to associate event reports with the originating physical events [8]. Physical time is also crucial for determining properties such as speed or acceleration.

b) ***Sensor network – real world*** In sensor networks, many sensor nodes may observe a single physical phenomenon. One of the key functions of a sensor network is hence the assembly of those distributed observations into a coherent estimate of the original phenomenon- this process is known as data fusion. Time is a key ingredient for data fusion. Since many instances of a physical phenomenon can occur within a short time, one of the tasks of a sensor network is the separation of sensor samples, that is



Applications of physical time: (a) interaction of an external observer with the sensor network, (b) interaction among sensor nodes, and (c) interaction of the sensor network with the real world.

c) ***Within sensor network*** Time is also a valuable tool for intra-network coordination among different sensor nodes. One particularly important example for concurrency control is the use of time division multiplexing in wireless communication, where multiple access to the shared communication medium is typically achieved by assigning time slots to the communicating nodes. This requires the participating sensor nodes to share a common view of physical time.

Future Work is based on finding solutions for time synchronization. Due to Time Asynchronization change in various parameters are there like reduction in Network Lifetime, Unicast Received Throughput and other parameters like Average Unicast End To End Delay, Average Unicast Jitter and Number of Data Packets Dropped Due to Channel Access get increased. For Synchronizing these parameters we have to find the solutions.

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